

Benefit Cost Analysis

Optimizing Projects for
Cross-Disciplinary Benefits

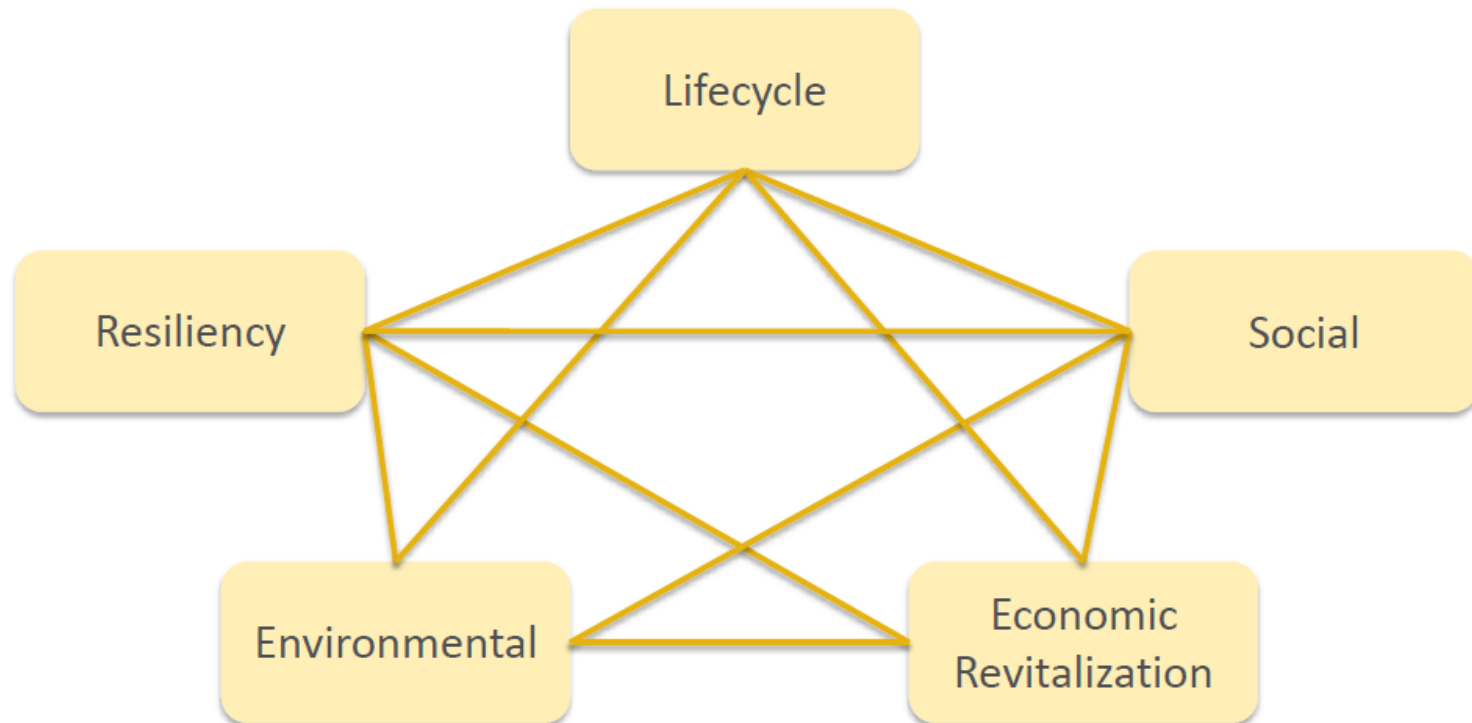


Session Overview

- Purpose of the session includes:
 - Understand the BCA requirements
 - Obtain examples of cross-disciplinary benefits
 - Evaluate your project for additional benefits

BENEFIT-COST CATEGORIES

Categories are Interrelated and Synergistic



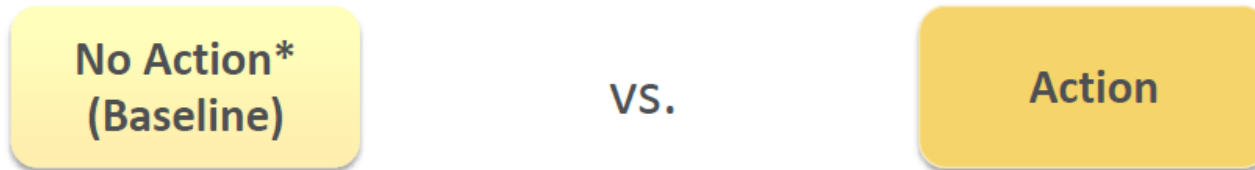
BENEFIT-COST ANALYSIS OVERVIEW

Federal Benefit Cost Approaches



BENEFIT-COST ANALYSIS OVERVIEW

Framing the Analysis



* No Action does not mean that costs and benefits won't change over time.

BENEFIT-COST ANALYSIS OVERVIEW

Assessing the Costs and Benefits

Identify

Is the cost or benefit relevant to the project?

Quantitative
Assessment

Can the cost or benefit be quantified in physical terms –
is the data available?

Monetized
Effect

Can a dollar value be assigned to the cost or benefit?
(total, per-acre, per-person, per-event, etc.)

BENEFIT-COST ANALYSIS OVERVIEW

High-Level BCA Steps

Identify

- ☐ Define the Details (project scope, components, and phases)
- ☐ Identify Stakeholders
- ☐ Determine Benefit/Cost Categories
- ☐ Establish Expected Project Life

Quantitative Assessment

- ☐ Gather Field Data (survey, physical, historic, etc)
- ☐ Review Available Literature and Federal Data Sources
- ☐ Gather Construction/Remediation Details and Costs
- ☐ Develop GIS Maps and Other Resources
- ☐ Build Simple Models to Predict and Understand Quantities

Monetized Effect

- ☐ Define Valuation Approach and Assumptions
- ☐ Collect Appropriate Values from Primary Research and Literature
- ☐ Build Simple Financial Spreadsheets and Enter Data
- ☐ Verify that Data is Realistic and Answers Necessary Questions

Describe Quantitative and Qualitative Results and Findings

BENEFIT-COST ANALYSIS OVERVIEW

CDBG-NDR Basic Assumptions

Analysis Period

Appropriate to the useful life of the project

Price Level

2015 Constant Prices

Inflation

No general price inflation

Discount Rate

7% Per OMB Circular A-94. Alternate rate down to 3% can be used with justification.

Value of Statistical Life

FEMA's estimates based on Federal Aviation Administration's 2008 ratings

JUSTIFYING A LOWER DISCOUNT RATE

Discount rates used in a BCA have a substantial impact on the resulting benefit-cost ratio. This is one of the most hotly debated topics in economics today.

Higher rates result in a preference for projects that have more immediate benefits and lower immediate costs. Many argue that this creates a bias against long-term, sustainable solutions including green infrastructure.

Consider completing a sensitivity analysis with a lower discount rate for projects, especially green infrastructure, that will provide level or increasing benefits far into the future, for example;

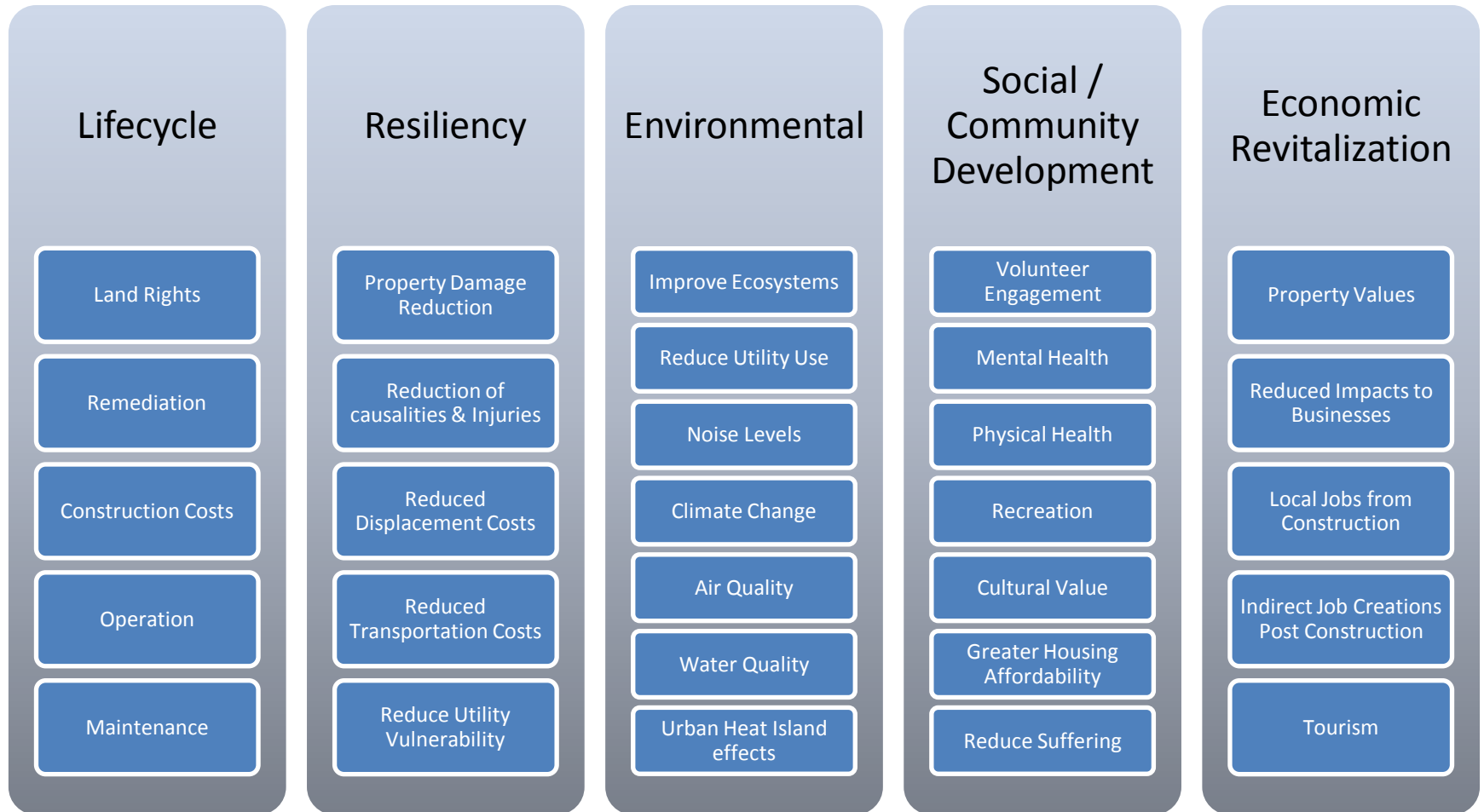
- Forest management and habitat development for wildfire reduction;
- Creation of wetlands and barrier islands for flood protection;
- Projects related to watersheds and long-term water supply.

NOFA Measureable Benefits

Benefit & Cost Categories

Project Components	Lifecycle	Resiliency	Economic Revitalization	Environmental	Social	Leverage / Philanthropy	Policy
Green Infrastructure & Natural System	✓	✓		✓	✓	✓	✓
Buyouts & Other Land Use Benefits	✓	✓		✓	✓	✓	✓
Critical Built Infrastructure	✓	✓	✓				✓

Cost and Benefit Categories



Lifecycle Costs – Useful Life

Project Type	Useful Life (years)		Comment
	Standard Value	Acceptable Limits (documentation required)	
Acquisition/Relocation			
All Structures	100	100	
Elevation			
Residential Building	30	30–50	
Non-Residential Building	25	25–50	
Public Building	50	50–100	
Historic Buildings	50	50–100	
Structural/Non-Structural Building Project			
Residential Building Retrofit	30	30	
Non-Residential Building Retrofit	25	25–50	
Public Building Retro fit	50	50–100	
Historic Building Retrofit	50	50–100	
Roof Diaphragm Retrofit	30	30	Roof hardening and roof clips
Tornado Safe Room – Residential	30	30	
Tornado Safe Room – Community	30	30–50	Retrofit or small community safe room ≤ 16 people (30 yr), New (50 yr)
Non-Structural Building Elements	30	30	Ceilings, electrical cabinets, generators, parapet walls, or chimneys
Non-Structural Major Equipment	15	15–30	Elevators, HVA C, sprinklers
Non-Structural Minor Equipment	5	5–20	Generic contents, racks, shelves
Infrastructure Projects			
Major Infrastructure (minor localized flood reduction projects)	50	35–100	
Concrete Infrastructure, Flood Walls, Roads, Bridges, Major Drainage System	50	35–50	
Culverts (concrete, PVC, CMP, HDPE, etc.)	30	25–50	Culvert with end treatment (i.e., wing walls, end sections, head walls, etc.)
	10	5–20	Culvert without end treatment (i.e., wing walls, end sections, head walls, etc.)
Pump Stations, Substations, Wastewater Systems, or Equipment Such as Generators	50	50	Structures
	5	5–30	Equipment
Hurricane Storm Shutters	15	15–30	Depends on type of storm shutter
Utility Mitigation Projects	50	50–100	Major (power lines, cable, hardening gas, water, sewer lines, etc.)
	5	5–30	Minor (backflow valves, downspout disconnect, etc.)

Source:
FEMA BCA Reference Guide
Appendix D

Resiliency – Property Damage Reduction

FEMA FIRM
H&H Models

Flood Elevation verse Probability

Storm	Probability	Elev
100-yr	0.01	624.63
50-yr	0.02	624.04
25-yr	0.04	623.24
10-yr	0.1	622.34
5-yr	0.2	621.59
2-yr	0.5	620.41

Structure Survey
DEM + HtFF

First Floor = 624 ft

Depth
0.63
0.04
-0.76
-1.66
-2.41
-3.59



Depth verse Damage

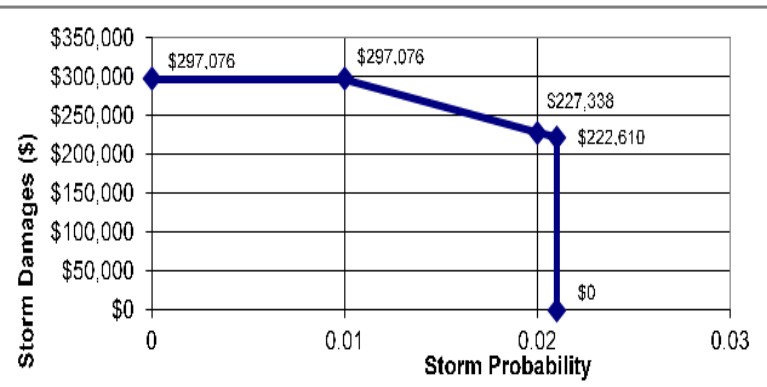
Depth	Damages
0.63	\$297,076
0.04	\$227,338
-0.76	\$0
-1.66	\$0
-2.41	\$0
-3.59	\$0

USACE
EGM 01-03 (Res no bas.)
EGM 04-01 (Res w/ bas.)
EGM 09-04 (Vehicles)
FEMA Default DDF (non-res)

Calculation of Average Annual Damage

Storm Frequency	Storm Probability	Total Damage	Delta 1/RI	Average Damages in Interval	AAD in Interval
Infinite	0	\$297,076			
			0.01	\$297,076	\$2,971
100	0.01	\$297,076			
			0.01	\$262,207	\$2,622
50	0.02	\$227,338			
			0.001	\$224,974	\$225
47.6	0.021	\$222,610			
			0	\$111,305	\$0
47.6	0.021	\$0			

Average Annual Damages \$5,818



Analysis Model
FEMA BCA IDNR
Damages
FEMA HAZUS
HEC-FDA

Resiliency - Displacement

- Duration
 - 45 days per foot of water above first floor elevation
- FY15 Per Diem (<http://www.gsa.gov/portal/category/100120>)

[illegible]

Resiliency - Other

- Transportation
 - FEMA Standard Values for Loss of Service for roads:
 - Loss of road/bridge service: \$38.15/vehicle/hour
 - Mileage: Use current Federal Mileage Rate
 - http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentId=17943&contentType=GSA_BASIC&queryYear=2008
- Utility
 - FEMA Standard Values for Loss of Service for utilities:
 - Loss of electric power: \$126/person/day
 - Loss of potable water: \$88/person/day
 - Loss of wastewater: \$41/person/day

Environmental - Emissions

Recommended Monetized Value(s)			Reference and Notes																		
<table><tr><th>Emission Type</th><th>\$ / short ton (\$2013)</th><th>\$ / metric ton (\$2013)</th></tr><tr><td>Carbon dioxide (CO₂)</td><td>(varies)*</td><td>(varies)*</td></tr><tr><td>Volatile Organic Compounds (VOCs)</td><td>\$1,813</td><td>\$1,999</td></tr><tr><td>Nitrogen oxides (NO_x)</td><td>\$7,147</td><td>\$7,877</td></tr><tr><td>Particulate matter (PM)</td><td>\$326,935</td><td>\$360,383</td></tr><tr><td>Sulfur dioxide (SO_x)</td><td>\$42,240</td><td>\$46,561</td></tr></table>			Emission Type	\$ / short ton (\$2013)	\$ / metric ton (\$2013)	Carbon dioxide (CO ₂)	(varies)*	(varies)*	Volatile Organic Compounds (VOCs)	\$1,813	\$1,999	Nitrogen oxides (NO _x)	\$7,147	\$7,877	Particulate matter (PM)	\$326,935	\$360,383	Sulfur dioxide (SO _x)	\$42,240	\$46,561	<p><i>Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks</i> (August 2012), page 922, Table VIII-16, "Economic Values Used for Benefits Computations (2010 dollars)" http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/FRIA_2017-2025.pdf</p> <p>The Resource Guide converts these values into 2013 dollars.</p> <p>NOTE: Emissions units are frequently reported as "tons" throughout documents such as the CAFE rulemaking referenced above. There is a distinction between short tons, long tons, and metric tons, however. Carbon dioxide emissions (as reported in the SCC guidance and elsewhere) are typically reported in metric tons, whereas emissions for VOCs, NO_x, PMs, and SO_x are measured in short tons. The English "long ton" is not used in these tabulations. A short ton is 2000 lbs., while a metric ton is approximately 2,205 lbs., and a long ton is 2,240 lbs.</p>
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<p>* See "Social Cost of Carbon (3%)" values below.</p> <p>1 Gallon of Gas burned = 17.7 pounds of CO₂</p>																					

Source: Tiger Benefit Cost Analysis Resource Guide

Environmental - Emissions

Recommended Monetized Value(s)		Reference and Notes																																																																																							
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Environmental – Open Space

- Green Open Space \$7,853.27 per acre
- Riparian \$37,493.20 per acre

Social / Community Development

Injury & Loss of Life

Table 4: AIS Injury Level Categories

AIS Code	Injury Severity Level	Selected Injuries
1	Minor	Superficial abrasion or laceration of skin; digit sprain; first-degree burn; head trauma with headache or dizziness (no other neurological signs).
2	Moderate	Major abrasion or laceration of skin; cerebral concussion (unconscious less than 15 minutes); finger or toe crush/amputation; closed pelvic fracture with or without dislocation.
3	Serious	Major nerve laceration; multiple rib fracture (but without flail chest); abdominal organ contusion; hand, foot, or arm crush/amputation.
4	Severe	Spleen rupture; leg crush; chest-wall perforation; cerebral concussion with other neurological signs (unconscious less than 24 hours).
5	Critical	Spinal cord injury (with cord transection); extensive second- or third-degree burns; cerebral concussion with severe neurological signs (unconscious more than 24 hours).
6	Fatal	Injuries, which although not fatal within the first 30 days after an accident, ultimately result in death.

Source: FAA, 2007

Federal agencies such as the Federal Aviation Administration (FAA), US Department of Transportation (USDOT), and National Highway Traffic Safety Administration (NHTSA) calculate an economic value for avoiding different AIS scale injuries by using the relative value coefficients as a fraction of the VSL. By following this methodology, FEMA is able to establish an economic value for the various injury levels that could be avoided – and therefore counted as benefits – from a hazard mitigation project. These economic values are shown in Table 5. The BCA software uses the following values for the different hazard types.

Table 5: AIS Injury Severity Levels, Fraction of VSL, and Economic Values (2012 Dollars)

AIS Code	Description of Injury	Fraction of VSL	Economic Value
AIS 1	Minor	.0020	\$13,000
AIS 2	Moderate	.0155	\$102,000
AIS 3	Serious	.0575	\$379,000
AIS 4	Severe	.1875	\$1,237,000
AIS 5	Critical	.7625	\$5,032,000
AIS 6	Fatal	1.0000	\$6,600,000

Source for Fraction of VSL: FAA, 2008.

Taken from
NOFA Appendix H

Social / Community Development

Reduced Stress & Anxiety

- Mental Stress & Anxiety
 - \$2,443 treatment cost per person
- Worker Lost Productivity
 - \$8,736

Social / Community Development Health Benefits

- Mortality reduction due to walking:
 - 11 percent (3 hours per week)
- Mortality reduction due to cycling:
 - 10 percent (90 minutes per week at 11mph)
- Premature death is valued at \$9.1 million in 2009

Source: <http://www.railstotrails.org/policy/active-transportation-for-america/quantifying-benefits/>

Economic Revitalization - Transportation

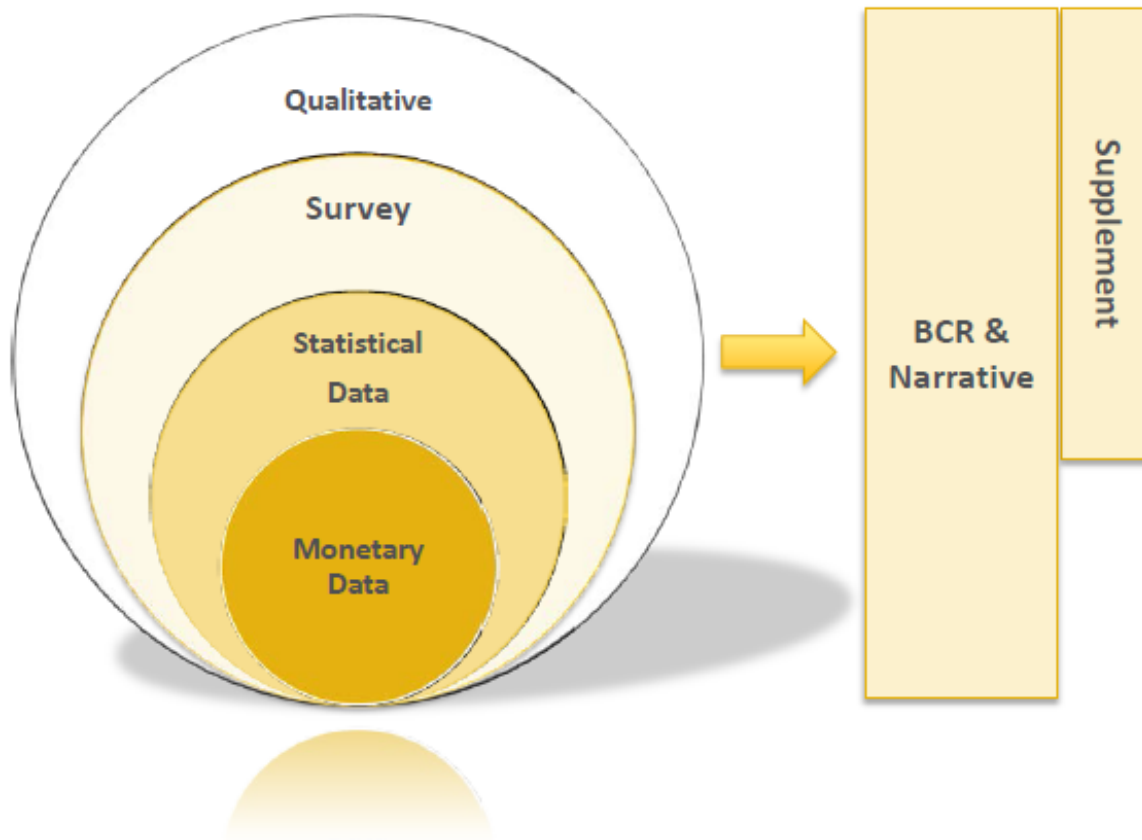
Recommended Monetized Value(s)			Reference and Notes																											
<div>Recommended Hourly Values of Travel Time Savings (2013 U.S. \$ per person-hour)</div> <table><tr><th>Category</th><th>Surface Modes* (except High-Speed Rail)</th><th>Air and High-Speed Rail Travel</th></tr><tr><td colspan="3">Local Travel</td></tr><tr><td>Personal</td><td>\$12.50</td><td></td></tr><tr><td>Business</td><td>\$24.40</td><td></td></tr><tr><td>All Purposes **</td><td>\$13.00</td><td></td></tr><tr><td colspan="3">Intercity Travel</td></tr><tr><td>Personal</td><td>\$17.50</td><td>\$33.20</td></tr><tr><td>Business</td><td>\$24.40</td><td>\$60.70</td></tr><tr><td>All Purposes **</td><td>\$19.00</td><td>\$44.30</td></tr></table> <div><div>Truck Drivers\$25.80</div><div>Bus Drivers\$26.70</div><div>Transit Rail Operators\$46.30</div><div>Locomotive Engineers\$38.70</div><div>Airline Pilots and Engineers\$84.20</div></div> <div><p>* Surface figures apply to all combinations of in-vehicle and other transit time. Walk access, waiting, and transfer time in personal travel should be valued at \$24.97 per hour for personal travel when actions affect only those elements of travel time.</p><p>** These are weighted averages, using distributions of travel by trip purpose on various modes. Distribution for local travel by surface modes: 95.4% personal, 4.6% business. Distribution for intercity travel by conventional surface modes: 78.6% personal, 21.4% business. Distribution for intercity travel by air or high-speed rail: 59.6% personal, 40.4% business. Surface figures derived using annual person-miles of travel (PMT) data from the 2001 National Household Travel Survey. http://nhts.ornl.gov/. Air figures use person-trip data.</p></div>			Category	Surface Modes* (except High-Speed Rail)	Air and High-Speed Rail Travel	Local Travel			Personal	\$12.50		Business	\$24.40		All Purposes **	\$13.00		Intercity Travel			Personal	\$17.50	\$33.20	Business	\$24.40	\$60.70	All Purposes **	\$19.00	\$44.30	<div>Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis (Revision 2 – corrected)</div> <div>http://www.dot.gov/office-policy/transportation-policy/guidance-value-time</div> <div>Don't Double Count Benefits!</div>
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Don't Double Count Benefits!

Appendix H Required Table

1	2	3	4	5	6
Costs and Benefits by category	Page # in Factor Narratives or BCA Attachment	Qualitative Description of Effect and Rationale for Including in BCA	Quantitative assessment (Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)	Monetized effect (if applicable)	Uncertainty
Life cycle costs					
<i>One row for each effect Name</i>				\$	
Resiliency Value					
<i>One row for each effect</i>				\$	
Environmental Value					
<i>One row for each effect</i>				\$	
Community Development Value					
<i>One row for each effect</i>				\$	
Economic Revitalization					
<i>One row for each effect</i>				\$	

SUMMARY



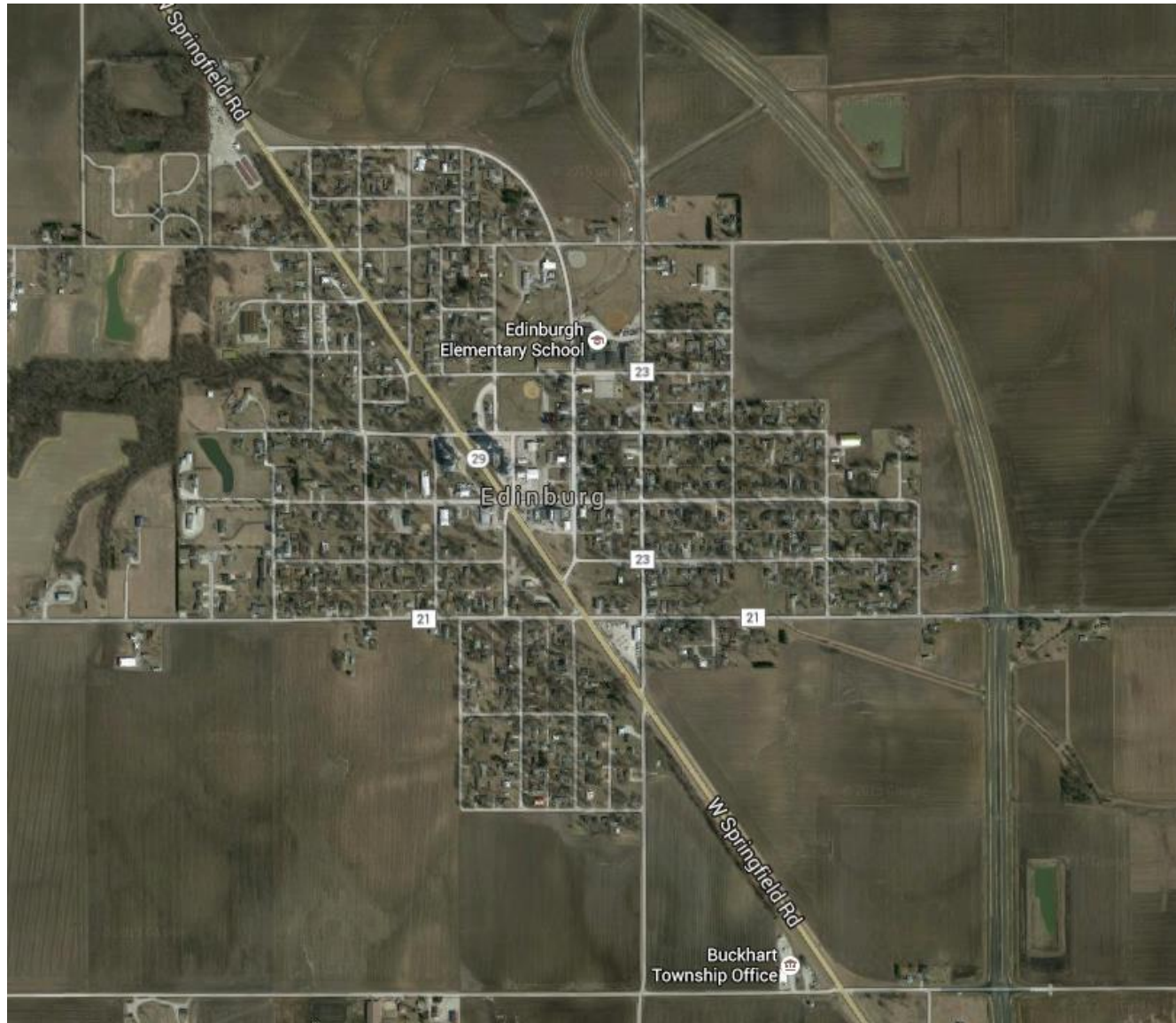
What if $BCR < 1$?

A.) Provide compelling evidence of non-monetized value via a thorough 3-page supplement

B.) Revisit the project

- Modify the scope and assumptions
- Evaluate more promising alternatives
- Identify new categories of benefits and cost reductions

Example – What Could Have Been



Resilience Value



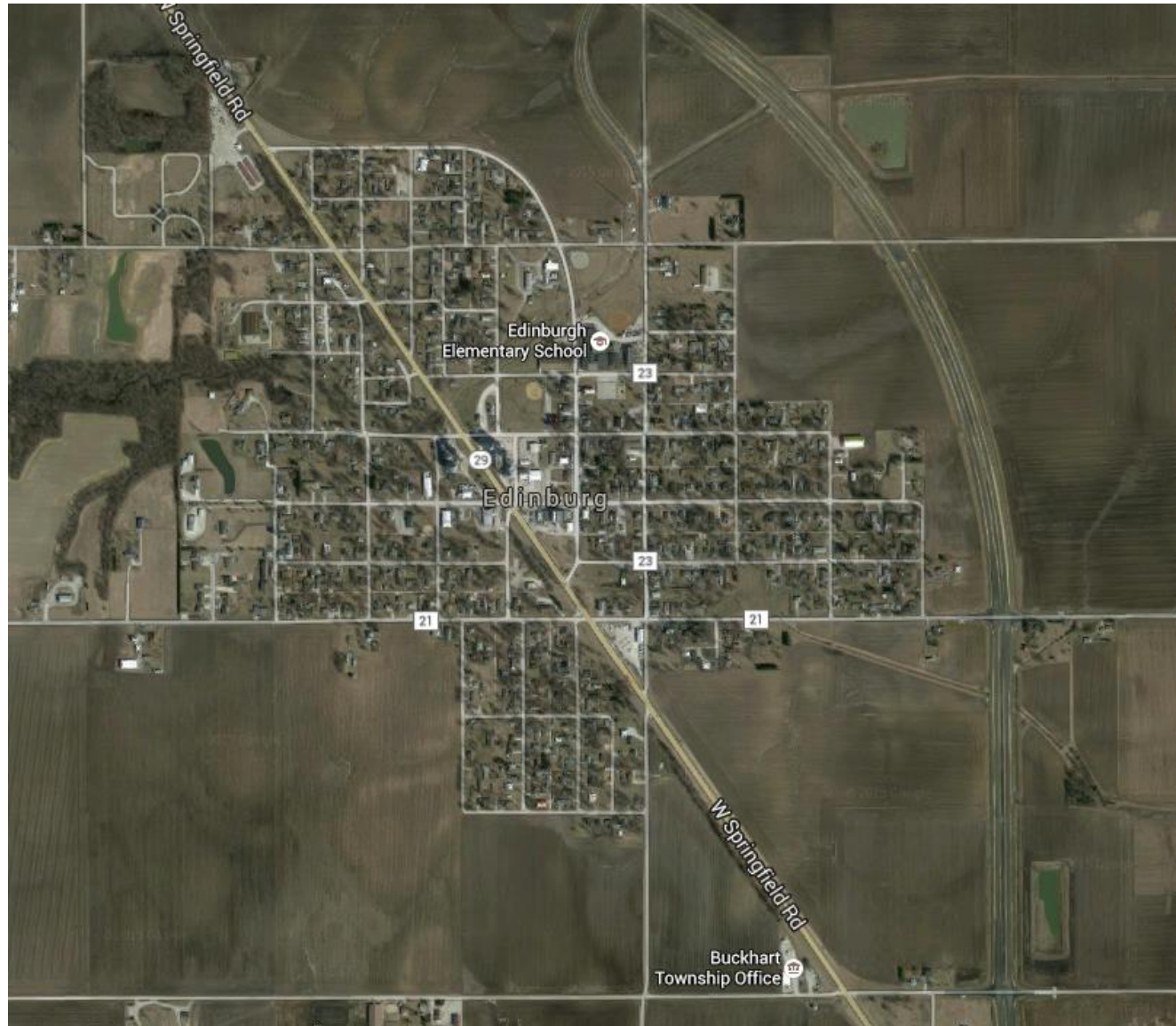
Resilience
Benefits

Environmental
Benefits

Social
Benefits

Economic
Benefits

Example – What did they get?



Transportation Benefits
for non-local traffic

Reduced Economic
Benefits

2 Unutilized Ponds

Resources

- FEMA BCA resources:
 - <http://www.fema.gov/benefit-cost-analysis>
- FEMA BCA Toolkit Version 5.1
 - <http://www.fema.gov/media-library/assets/documents/92923>
- TIGER BENEFIT-COST ANALYSIS (BCA) RESOURCE GUIDE
 - https://www.transportation.gov/sites/dot.gov/files/docs/Tiger_Benefit-Cost_Analysis_%28BCA%29_Resource_Guide_1.pdf
- HUD BCA Overview Webinar
- HUD BCA Data Resources and Expert Tips Webinar

Benefit Cost Workshop

- Find Sheets in your packet marked:
 - Exercise 5 (Rockefeller Foundation Pages 16-19)
 - Identifying Project Benefit Categories
 - Identifying Project Cost Categories
 - Crafting the BCA
- Utilize the Technical Experts Available

EXERCISE 5

Evaluating Project Components: Track 1: Project Finance

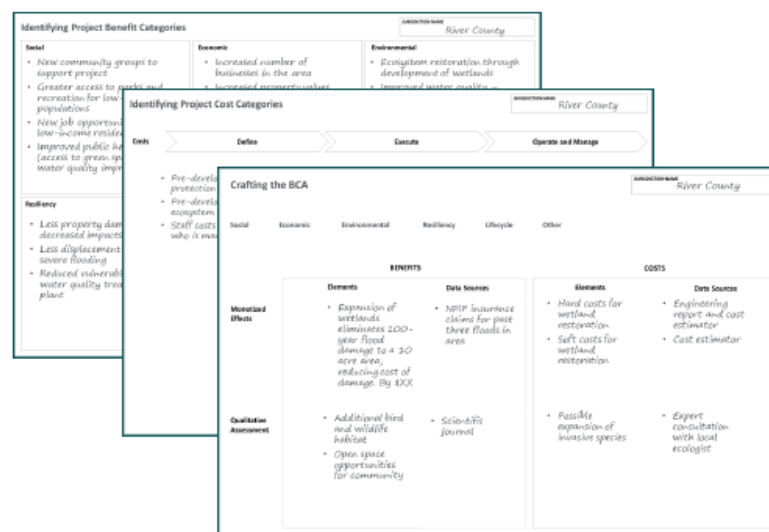


The Benefit-Cost Analysis (BCA, part of Factor 3) and Leverage (Factor 4) are critical components of the NOFA application.

This exercise will help teams define in greater detail the elements that contribute to the resilience value of the project and to use those benefits to identify creative financing strategies for the project.

Steps include:

- Generate a list of Resilience Project Benefit and Cost Categories
- Generate initial BCA content elements
- Generate a project financing strategy



EXERCISE 5A

Evaluating Project Components: Track 1: Project Finance

Where are we?

Grounding

Where do we want to be?

Resilience Values

Opportunity Statement

Project Design

Success Factors

How will we get there?

Key Issues

Benefit Cost Analysis

Financing Strategy

Policy and Planning

Key Stakeholders

A

Benefits

- Describe the quantitative and qualitative resilience benefit elements of resilience projects. The list should include social, economic, environmental, and resiliency benefits.
- Review the Project Values and Drivers to consider the project Benefits.

PROJECT NAME River County		
Social <ul style="list-style-type: none"> New community groups to support project Greater access to parks and recreation for low-income populations New job opportunities for low-income residents Improved public health (access to green space and water quality improvements) 	Economic <ul style="list-style-type: none"> Increased number of businesses in the area Increased property values 	Environmental <ul style="list-style-type: none"> Ecosystem restoration through development of wetlands Improved water quality – reduced stormwater runoff
Resiliency <ul style="list-style-type: none"> Less property damage due to decreased impacts of flooding Less displacement due to severe flooding Reduced vulnerability of water quality treatment plant 	Other <ul style="list-style-type: none"> Increased coordination among government agencies New partnerships with community organizations and academic institutions Improvements to building code 	

Costs

- What are the cost elements for built projects (e.g. hard costs, soft costs) and program cost elements (e.g. service costs, staff, administrative costs and overhead, material costs) of your project?
- What are the programmatic costs of the project at various stages?
- What additional costs should be considered for operations and maintenance of the project?

PROJECT NAME River County			
Costs	Define	Execute	Operate and Manage
<ul style="list-style-type: none"> Pre-development costs for flood protection Pre-development costs for ecosystem restoration Staff costs of government staff who is managing design process 	<ul style="list-style-type: none"> Hard costs for flood protection Soft costs for flood protection Ecosystem restorations soft costs Ecosystem restorations hard costs Regional coordinator staff costs Start-up material costs for business development fund program 	<ul style="list-style-type: none"> Maintenance costs for flood protections Ongoing monitoring staff costs Ongoing operating costs for business development fund program (materials, staff, overhead) 	

EXERCISE 5A

Evaluating

Project Components:

Track 1: Benefit-Cost Analysis



Teams will use benefit and cost categories to develop specific benefits and costs elements for each one of the classifications specified in the NOFA, i.e. social, economic, environmental, resilience, and lifecycle.

Teams should fill out one handout per NOFA category, circling the relevant category at the top of the handout.

Handout: Crafting the BCA

Crafting the BCA						JURISDICTION NAME River County
Social	Economic	Environmental	Resiliency	Lifecycle	Other	
BENEFITS						
	Elements <ul style="list-style-type: none"> Expansion of wetlands eliminates 100-year flood damage to a 10 acre area, reducing cost of damage. By \$XX 		Data Sources <ul style="list-style-type: none"> NFIP insurance claims for past three floods in area 			
Monetized Effects						
COSTS						
	Elements <ul style="list-style-type: none"> Additional bird and wildlife habitat Open space opportunities for community 		Data Sources <ul style="list-style-type: none"> Scientific journal 			
Qualitative Assessment						
	Elements <ul style="list-style-type: none"> Hard costs for wetland restoration Soft costs for wetland restoration 		Data Sources <ul style="list-style-type: none"> Engineering report and cost estimator Cost estimator 			
	Elements <ul style="list-style-type: none"> Possible expansion of invasive species 		Data Sources <ul style="list-style-type: none"> Expert consultation with local ecologist 			

EXERCISE 5A

ILLUSTRATIVE SAMPLE HANDOUTS

Identifying Project Benefit Categories

JURISDICTION NAME
River County

Social

- New community groups to support project
- Greater access to parks and recreation for low-income populations
- New job opportunities for low-income residents
- Improved public health (access to green space and water quality improvements)

Economic

- Increased number of businesses in the area
- Increased property values

Environmental

- Ecosystem restoration through development of wetlands
- Improved water quality – reduced stormwater runoff

Resiliency

- Less property damage due to decreased impacts of flooding
- Less displacement due to severe flooding
- Reduced vulnerability of water quality treatment plant

Other

- Increased coordination among government agencies
- New partnerships with community organizations and academic institutions
- Improvements to building code

Identifying Project Cost Categories

JURISDICTION NAME
River County

Costs

Define

Execute

Operate and Manage

- Pre-development costs for flood protection
- Pre-development costs for ecosystem restoration
- Staff costs of government staff who is managing design process

- Hard costs for flood protection
- Soft costs for flood protection
- Ecosystem restorations soft costs
- Ecosystem restorations hard costs
- Regional coordinator staff costs
- Start-up material costs for business development fund program

- Maintenance costs for flood protections
- Ongoing monitoring staff costs
- Ongoing operating costs for business development fund program (materials, staff, overhead)

Crafting the BCA

JURISDICTION NAME
River County

Social Economic Environmental Resiliency Lifecycle Other

BENEFITS

Elements

- Expansion of wetlands eliminates 100-year flood damage to a 20 acre area, reducing cost of damage. By \$XX

Data Sources

- NFIP insurance claims for past three floods in area

Monetized Effects

Qualitative Assessment

- Additional bird and wildlife habitat
- Open space opportunities for community

- Scientific journal

COSTS

Elements

- Hard costs for wetland restoration
- Soft costs for wetland restoration

Data Sources

- Engineering report and cost estimator
- Cost estimator

- Possible expansion of invasive species

- Expert consultation with local ecologist

